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(54) ODOR/GAS FLOW VISUALIZING DEVICE AND ODOR/GAS FLOW MEASUREMENT DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an odor/gas flow visualizing device used without requiring selection of a gas sensor arrangement position and hardly affected by a local turbulence of wind so as to quickly determine the direction of the odor/gas flow with high reliability.

SOLUTION: This device is provided with an odor/gas flow measurement means consisting of a combination of a plurality of sensor arrays, in each of which a single or more odor/gas sensor is arranged on a two-dimensional plane, and measuring a change of concentration of odor/gas flow in multiple points and a visualizing means visualizing the concentration change measured by the odor/gas flow measuring means.

CLAIMS

[Claim(s)]
[Claim 1]A smell and a gas stream visualization device characterized by comprising the following
1, or two or more smells and gas sensors are followed for carrying out multipoint measurement of the concentration change of a smell and a gas stream combining two or more sensor arrays arranged on a two-dimensional flat surface, and it is a gas stream measurement means.
A visualizing means which visualizes a concentration change measured by this smell and gas stream measurement means.

[Claim 2]A smell and a gas stream metering device characterized by comprising the following
1, or two or more smells and gas sensors are followed for carrying out multipoint measurement of the concentration change of a smell and a gas stream combining two or more sensor arrays arranged on a two-dimensional flat surface, and it is a gas stream measurement means.
A visualizing means which visualizes a concentration change measured by this smell and gas stream measurement means, and a measuring means which measures a direction and the rate of flow of a smell and a gas stream based on said visualized concentration change.

[Claim 3]A smell and the gas stream metering device according to claim 1 or 2 having consisted a predetermined interval in said 1 or two or more sensor arrays, and arranging a plate parallel to the detection face on them in this detection face.
[Claim 4]A sensor array which arranged 1, or two or more smells and gas sensors on a two-dimensional flat surface, A visualizing means which visualizes a concentration change this measured by this sensor array by carrying out multipoint measurement of

the concentration change of a smell and a gas stream is provided, and it takes for being characterized by having consisted a predetermined interval in said sensor array, and arranging a plate parallel to that detection face on it in this detection face, and is - gas stream visualization device.

[Claim 5]A sensor array which arranged 1, or two or more smells and gas sensors on a two-dimensional flat surface, A visualizing means which visualizes a concentration change this measured by this sensor array by carrying out multipoint measurement of the concentration change of a smell and a gas stream, A measuring means which measures a direction and the rate of flow of a smell and a gas stream based on said visualized concentration change is provided, and it takes for being characterized by having consisted a predetermined interval in said sensor array, and arranging a plate parallel to the detection face on it in this detection face, and is - gas stream visualization device.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]the inside of the air is drifted using the small sensor array which put the smell and the gas sensor in order -- the flow of smell gas is visualized as video -- a smell, a gas stream visualization device, and it were used -- it is related with a smell and a gas stream metering device.

[0002]

[Description of the Prior Art]Conventionally, there are the following researches as a device which searches for the source of release of a smell and gas.

[0003](1) Yukio Hiranaka, Hiroo Yamazaki: Visualization of the gas concentration distribution by a semiconductor-gas-sensor array Transaction of Sensor Technology Research and ST-88-4, IEE of Japan, 1988, and a pp.33-42. gas sensor. It arranges on a two-dimensional flat surface, a huge sensor array is manufactured, and the overview of the gas concentration distribution which spreads from a source of release is measured. The acquired image is visualized on a computer screen and a source-of-release position understands it by looking for the place where concentration is the highest. However, it is necessary to arrange a sensor beforehand at the place expected that a smell and gas are emitted, and flexibility is missing.

[0004](2) In order to solve the problem of JP,7-12671,A and the JP,7-260618,A above (1), the invention-in-this-application person proposed the method of moving in the acquired direction using the compact apparatus which judges the direction of a source of release, and searching for a source of release. The sensor and gas sensor which search

for a wind direction are used, and the direction of a source of release is judged combining the gas concentration inclination and wind direction which were measured by one in space. However, a wind receives the influence of disorder of a local wind in an unstable environment, and the reliability of a direction judging is low. Since there were few wind-direction sensors applicable to the fine wind speed of 5 or less cm/s of wind speeds like the general interior of a room, use in such environment was difficult.

[0005](3) In order to solve the problem of the wind direction sensor in JP,8-261893,A and the eight to Japanese-Patent-Application-No. 121996 above (2), the invention-in-this-application person proposed the direction determining device of a source of release of the method which does not use this. Gas is attracted from the front using a small fan, the response difference of the gas sensor arranged in in front of a fan is measured, and the direction of a smell and a gas source is judged. However, in order to judge based on the information acquired by one point of space like the above (2), there is a problem of being easy to receive the influence of disorder of a local wind.

[0006]

[Problem(s) to be Solved by the Invention]As explained above, when performing the direction judging of a smell and a gas source conventionally, there was a problem that selection of the locating position of a smell gas sensor was difficult, or tends to receive the influence of disorder of a local wind.

[0007]Then, when this invention performs multipoint measurement of a smell and gas concentration change using many smells and gas sensors, By being hard to receive the influence of local disorder of a wind, attaining a reliable direction judging for a short time, and moreover performing the direction judging of a smell and a gas source using a small portability sensor array, the sensor does not need to be beforehand arranged around the source of release of a smell and a gas stream -- flexibility -- it is high -- a smell, a gas stream visualization device, and it were used -- it aims at providing a smell and a gas stream metering device.

[0008]Namely, according to the smell and the gas stream visualization device of this invention, the small sensor array which put the smell and the gas sensor in order is used, It flows on this small sensor array, the inside of last air is followed for drifting, the flow of - gas is visualized as video, and if it moves according to the direction to which this points, the source of release of a smell or gas can be discovered easily and correctly. Speed to the direction and the wind direction into which a smell and gas flow, and a wind speed are measurable.

[0009]

[Means for Solving the Problem](1) This invention is characterized by a smell and a gas stream visualization device comprising the following.

1, or two or more smells and gas sensors are followed for carrying out multipoint measurement of the concentration change of a smell and a gas stream combining two or more sensor arrays arranged on a two-dimensional flat surface, and it is - gas stream

measurement means.
A visualizing means which visualizes a concentration change measured by this smell and gas stream measurement means.
According to this invention, it is not necessary to select a locating position of a smell and a gas sensor, and is hard to receive influence of local disorder of a wind, and a direction judging of reliable smell and gas stream is attained for a short time. The simultaneous multipoint measurement of a smell and the gas stream from all directions can be carried out by using combining a sensor array which catches a smell and a gas stream on a position flat-surface target especially two or more. When a crystal oscillator smell and a gas sensor are used for a smell and a gas sensor, there is an advantage that it can follow quickly also in a momentary concentration change of a smell and gas.
[0010](2) This invention is characterized by a smell and a gas stream metering device comprising the following.
1, or two or more smells and gas sensors are followed for carrying out multipoint measurement of the concentration change of a smell and a gas stream combining two or more sensor arrays arranged on a two-dimensional flat surface, and it is - gas stream measurement means.
A visualizing means which visualizes a concentration change measured by this smell and gas stream measurement means.
A measuring means which measures a direction and the rate of flow of a smell and a gas stream based on said visualized concentration change.
According to this invention, it is not necessary to select a locating position of a smell and a gas sensor, and is hard to receive influence of local disorder of a wind, and a direction judging of reliable smell and gas stream is attained for a short time. Simultaneous multipoint measurement of a smell and the gas stream from all directions can be carried out by using combining a sensor array which catches a smell and a gas stream on a position flat-surface target especially two or more, and the direction of a smell and a gas stream and measurement of speed can be more correctly performed by compounding the result. When a crystal oscillator smell and a gas sensor are used for a smell and a gas sensor, there is an advantage that it can follow quickly also in a momentary concentration change of a smell and gas.
[0011](3) To the above 1 or two or more sensor arrays. By having consisted a predetermined interval in this detection face, and having arranged a plate parallel to the detection face on it, an ingredient which makes a sensor detection face generate turbulence among flow directions of a smell and a gas stream is covered, and can take out and measure only an ingredient parallel to a detection face. Therefore, the direction of a smell and a gas stream and measurement of speed can be performed more correctly.

[0012](4) A smell and a gas stream visualization device of this invention, A sensor array which arranged 1, or two or more smells and gas sensors on a two-dimensional

flat surface, A visualizing means which visualizes a concentration change this measured by this sensor array by carrying out multipoint measurement of the concentration change of a smell and a gas stream was provided, a predetermined interval was consisted in this detection face, and a plate parallel to that detection face was arranged on said sensor array in it. According to this invention, it is not necessary to select a locating position of a smell and a gas sensor, and is hard to receive influence of local disorder of a wind, and a direction judging of reliable smell and gas stream is attained for a short time. Especially an ingredient that makes a sensor detection face generate turbulence among flow directions of a smell and a gas stream by having consisted a predetermined interval in a sensor array and having arranged a plate parallel to the detection face on it in this detection face is covered, and can take out and measure only an ingredient parallel to a detection face. Therefore, the direction of a smell and a gas stream and measurement of speed can be performed more correctly. When a crystal oscillator smell and a gas sensor are used for a smell and a gas sensor, there is an advantage that it can follow quickly also in a momentary concentration change of a smell and gas.

[0013](5) A smell and a gas stream visualization device of this invention, A sensor array which arranged 1, or two or more smells and gas sensors on a two-dimensional flat surface, A visualizing means which visualizes a concentration change this measured by this sensor array by carrying out multipoint measurement of the concentration change of a smell and a gas stream, A measuring means which measures a direction and the rate of flow of a smell and a gas stream based on said visualized concentration change was provided, a predetermined interval was consisted in this detection face, and a plate parallel to the detection face was arranged on said sensor array in it. According to this invention, it is not necessary to select a locating position of a smell and a gas sensor, and is hard to receive influence of local disorder of a wind, and a direction judging of reliable smell and gas stream is attained for a short time. Especially an ingredient that makes a sensor detection face generate turbulence among flow directions of a smell and a gas stream by having consisted a predetermined interval in a sensor array and having arranged a plate parallel to the detection face on it in this detection face is covered, and can take out and measure only an ingredient parallel to a detection face. Therefore, the direction of a smell and a gas stream and measurement of speed can be performed more correctly. When a crystal oscillator smell and a gas sensor are used for a smell and a gas sensor, there is an advantage that it can follow quickly also in a momentary concentration change of smell gas.

[0014]

[Embodiment of the Invention]Hereafter, the embodiment of this invention is described with reference to drawings.

[0015](A 1st embodiment)

(Composition and operation) Drawing 1 shows the example of composition of the smell

and gas stream visualization device concerning this embodiment. The sensor array 3 used with this device A pulse drive type semiconductor smell and a gas sensor element. (For example, TGS2440, Figaro Research Institute) This is arranged in two-dimensional five-line array form of five rows using C11-C15, C21-C25, C31-C35, C41-C45, C51 - 25 C55. A length of one side of the array 3 is 55 mm, for example.

[0016]In order to detect thin smell and gas which drifts the inside of the air, a high sensitivity sensor is needed. If many large sensors of generation of heat are put in order and used under fine wind-speed environment, the array itself will cause a convection and it will change a flow. For this reason, a sensor with little consumed electric current is desirable.

[0017]There is a fault that the usual semiconductor smell and gas sensor have the large power consumption of the heater for element heating. Only when measuring a response, in order that an element may be heated momentarily and it may use it, its heater power consumption is small, and even if the pulse drive type sensor used by this embodiment puts many sensors in order, generation of heat is small [a sensor].

[0018]The personal computer 1 controls the whole device. The instructions from this computer 1 are received, the sensor for one line (five pieces) is chosen from the sensor array 3, power supply voltage is impressed, and the heater of the sensor for one selected line is heated at the moment in the control circuit 2. If a smell and gas are detected, electrical resistance will decrease, and the current which flows through an element increases a semiconductor smell and a gas sensor.

[0019]After the logarithmic transformation circuit 4 log transforms this current change and changes it into a digital signal from an analog signal with A/D converter 5, it downloads measured value to the computer 1.

[0020]The logarithmic transformation circuit 4 comprises 5 sets of operational amplifiers (logarithmic amplifier) 4a-4e, and the sensor of one row of the sensor array 3 long is connected to one circuit in parallel. Namely, the sensor response signal from the sensor elements C11-C15 is inputted into the operational amplifier 4a, The sensor response signal from the sensor elements C21-C25 is inputted into the operational amplifier 4b, The sensor response signal from the sensor elements C31-C35 was inputted into the operational amplifier 4c, the sensor response signal from the sensor elements C41-C45 was inputted into the operational amplifier 4d, and the sensor response signal from the sensor elements C51-C55 is inputted into the operational amplifier 4e.

[0021]Among these, current flows only into the sensor beside [selected in the control circuit 2] one line, and it has composition which measures five sensor responses beside one line simultaneously. By changing the line to choose one by one, all 25 sensor responses are measured and this operation is repeated every place time.

[0022]Next, with reference to the timing chart shown in drawing 2, operation of the sensor array 3 of drawing 1 is explained.

[0023]H1-H5 of drawing 1 are a power source wire which drives the heater of the sensor element of the sensor array 3. As shown in drawing 2, the heater voltage pulse of the width T1 is first impressed to the power source wire H1, and the five sensor elements C11 on a par with the 1st line (top line), C21, C31, C41, and C51 are heated. In order that a high current may flow momentarily even if it uses a pulse drive element if simultaneous heating of all the elements is carried out, the method heated for every line is taken. the power supply voltage at this time is 5V -- a heater voltage pulse -- the cycle T -- it gives repeatedly every 2= 0.25 second.

[0024]Measurement of a sensor response is performed for every T3 second from impression of a heater voltage pulse.

[0025]S1-S5 of drawing 1 are a power source wire for sensor element measure resistance. If the voltage pulse of 15 ms of width is given to the power source wire S1 as shown in drawing 2, current will flow into the five sensor elements C11 of the 1st line, C21, C31, C41, and C51. This is amplified with the operational amplifiers 4a-4e, and after changing into a digital signal from an analog signal with A/D converter 5, a value is measured with the personal computer 1.

[0026]Although the sensor element of the vertical single tier of the sensor array 3 is connected to each of the operational amplifiers 4a-4e in parallel, voltage is built only over the sensor element of the horizontal single tier to which the voltage pulse was applied, and current flows through the element.

[0027]As shown in drawing 2, a face of the above operation is carried out 15 ms respectively, for example, and it carries out to all the lines.

[0028]In the personal computer 1, the element resistance of a sensor is calculated from the measured current value, and sensor response r is calculated according to a following formula.

[0029]

r=Rgas/Rair -- (1)

However, Rgas expresses the element resistance of the sensor in a smell and gas, Rair expresses the element resistance of the sensor in the air, and r is a monotonically decreasing function of a smell and gas concentration.

[0030]The response calibration curve over ethano 1 RUGASU of the pulse drive type semiconductor smell and gas sensor used by this embodiment is shown in drawing 3. In the figure, sensor resistance Rgas in gas, and the ratio of the resistance Rair in the air and Rgas/Rair were used as sensor response r. It turns out that the gas of a thin ppm level is answered and sensor response r=Rgas/Rair is decreasing.

[0031]Now, since the obtained sensor response is converted into a video signal, the height of gas concentration is expressed with monochrome thickness (display brightness). It is the luminosity b of a pixel b=255x (1-r) -- (2)

By displaying by carrying out, gas concentration is high and the brighter picture in a smaller place is acquired for r. Here, the coefficient 255 is a gradation number of the

shade which can be displayed with the personal computer 1.

[0032](A smell and a gas stream visualization experiment) the smell and a gas stream visualization device which was explained above were used -- the smell and the gas stream visualization experiment were conducted by the air duct as shown in drawing 4. an air duct -- the smell and the gas sensor array 3 were mostly installed in the center, and breeze was made using the AC fan 11. Jetting volume from the rocket engine jets 12 was made into 50 ml/min as a smell and a gas source using the nozzle which spouts an ethano 1 RU saturated vapor. The distance of the rocket engine jets 12 and the sensor array 3 is 45 cm.

[0033]The smell and the diffusion rate of the gas molecule were dramatically slow, and it was emitted from the rocket engine jets 12, and smells, and a gas molecule is carried to a wind and spreads. If the wind in an air duct is completely laminar flow, a smell and gas will spread on the lee like the earnest continuous belt from the rocket engine jets 12. However, there is disorder in the wind of the air duct shown in drawing 3 like actual environment, and distribution of a smell and gas swings. For this reason, like the smoke which trails from a chimney, it takes with the pattern of a portion with high smell and gas concentration, and a low portion, and - gas cloud flows on the lee on the sensor array 3, and goes.

[0034]Five sensor elements on a par with a wind in parallel are chosen from 25 sensor elements of the sensor array 3, and the sensor response r is shown in drawing 5. The sensor element shown in drawing 5 is located in a line in order of No.20, No.19, No.18, No.17, and No.16 from the windward. It turns out that the response value of sensor element No.20 of the windward began reduction first, and the order with which the sensor element is located in a line is answered hereafter at ****** which answers a smell and gas from drawing 5. Conversely, although not shown in drawing 5, also when a sensor begins recovery, a response value begins an increase in the same order. An order of this response and recovery corresponds with direction of a smell and a gas stream.

[0035]Then, sensor response r of 25 sensor elements of the sensor array 3 is converted into a video signal and observed on a computer screen.

[0036]The result of having visualized 25 sensor responses of the sensor array 3 as video in such a situation is shown in drawing 6. The figure (a) - (d) is an image at the time of expressing the image at the time of a sensor element beginning a response in a smell and gas, a smell and gas passing (e) - (h), and a sensor beginning recovery. By drawing 6, although the white portion of the color expressed high-concentration smell and gas, the sensor response was binary-ized and the rectangle (it is deep-colored) with which the slanting slash went the solid rectangle (a color is white) into the place of the sensor which has not answered was drawn on the place of the sensor which has answered so that movement of a visualization image might be legible.

[0037]Signs that a smell and gas were flowing into the right from the left were checked

so that clearly from drawing 6.

[0038](Direction estimation algorithm) With the smell and a gas stream visualization device which was explained above, if the visualization picture of a smell and a gas stream as shown in drawing 6 is acquired, human being can see and judge the direction of a smell and a gas stream. It is also possible to judge a direction and the rate of flow automatically using various image processing algorithms. The personal computer 1 of drawing 1 can perform processing which judges a direction and the rate of flow from the visualization picture of this smell and gas stream.

[0039]It considers circuit-izing future calculation and performing a real-time operation here, The case where the automatic judging of a direction is performed is explained using the direction presuming method (B. KP.Horn, "robot vision" Asakura Publishing, 305-328, 1993) by the constrain equation of the easy optical flow of calculation.

[0040]It is assumed that it flows on the sensor array 3 in two dimensions while the molecular diffusion of a smell and gas was disregarded, and it was visualized, it smelled and - gas concentration distribution had maintained fixed shape. If x axial component of a smell and a gas stream is set to u and y axial component is set to v, it will be a constrain equation of an optical flow, [0041]

[Equation 1]

$$\frac{\partial b}{\partial x}u + \frac{\partial b}{\partial y}v + \frac{\partial b}{\partial t} = 0 \qquad \cdots (3)$$

[0042]It becomes.

[0043]If central-differences approximation of the differentiation which sets the display brightness of eye an i-th line j sequence with bij, and is included in an upper type (3) is carried out,[0044]

[Equation 2]

$$\frac{bi+1j(k\Delta t)-bi-1j(k\Delta t)}{2\Delta\ell}u+\frac{bij-1(k\Delta t)-bij+1(k\Delta t)}{2\Delta\ell}v + \frac{bij(k\Delta t+\Delta t)-bij(k\Delta t-\Delta t)}{2\Delta\ell} = 0 \qquad \cdots (4)$$

[0045]However, arrangement space deltal=11mm of a sensor element of the sensor array 3, sampling time deltat = suppose that it is 250 ms. It can be allied to i= 2, 3 and 4, j= 2, and 3 and 4 by flow velocity vector (u, v) of a smell and a gas stream, and it can ask for an upper type (4) with a least-squares method.

[0046]Here, in accordance with a technique mentioned above, a result of having performed presumption of the direction of a smell and a gas stream and the rate of flow is shown in drawing 7 to a visualization picture shown in drawing 6.

[0047]direction presumption -- sampling period delta -- although carried out every t= 250 ms, in a result shown in drawing 6, a point estimate of middle time of a picture which adjoins in drawing 5 was shown. A direction made facing the right 0 degree, and made a circumference of half:00 meter positive. The move direction of a picture shown in drawing 6 and an about corresponding direction were acquired. A wind in an air duct is changed focusing on 0 degree, and an acquired direction is in agreement with this.

[0048]Although it smelled and speed of - gas stream had a direction smaller than the time of a response of a sensor at the time of recovery, as for this, in order to visualize a flow of a smell or gas in real time, it is preferred [it was obtained, and / recovery speed of a sensor is because it is late compared with speed of response, and] that recovery of a sensor response uses a sensor high-speed enough. Or an operating condition of a sensor can be optimized and improvement in the speed of recovery speed of a sensor response can also be attained.

[0049]For example, with the above-mentioned T1 or a preset value of T3, since the response characteristic of a sensor changes, it should just optimize an operating condition of these smells and a gas sensor first.

[0050]That is, response sensitivity of a sensor also changes with data measurement timing T3 by time of recovery of a sensor response to ethanol gas becoming short, so that a value of the above-mentioned heater voltage pulse width T1 is small, and it falls, so that a value of T1 is made small. Then, what is necessary is to consider balance of sensitivity and recovery speed, and just to set up a value of T1 or T3 so that recovery may become high-speed, keeping sensitivity almost equivalent.

[0051]The rate of flow can visualize a smell and a gas stream to 1 - 2 cm/s about by optimizing an operating condition of a smell and a gas sensor, and improving recovery speed corresponding to ethanol gas of a sensor.

[0052](Conclusion) it drifts in the above-mentioned air in this way -- it searches for a source of release of a smell and gas -- according to a smell and the gas stream visualization device. Using the small sensor array 3 which put in order 5x5 a pulse drive type semiconductor smell and gas sensors, by regarding the sensor response as video, it takes for passing an array top and - gas stream is visualized. The direction of a smell and a gas stream is judged from an acquired picture, this is followed, and it searches for a smell and a gas source. Multipoint measurement (although it approves, a very small time lag (very small measuring time difference of a grade which can disregard a concentration change of a smell and a gas stream) of a line unit which was explained by this embodiment) A reliable direction judging is attained for a short time by performing simultaneous multipoint measurement by all the smell and gas sensors of the sensor array 3 substantially, and measuring a concentration change of a smell and gas. It can ask for a wind direction and a wind speed of a wind which carries a smell and gas from the move direction and speed of a picture.

[0053]As a result of conducting a visualization experiment of a smell and a gas stream

within an air duct, very small smell and gas stream of about 2 cm/s are visualized, it is checked that the direction of a smell and a gas stream can be correctly presumed using it, and application to fine wind-speed environment which was difficult to search, or big environment of disorder of a wind can be expected conventionally.

[0054]according to [as explained above] the above-mentioned embodiment -- a smell and the direction of a gas stream -- a short time -- reliability -- it becomes possible to judge highly and can search for a smell and a gas source easily. As a target for which it looks, a gas leak spot, a fire generation place, etc. can be considered. If it displays an acquired picture and human being not only judges a smell and the direction of a gas stream, but uses various image processing techniques, it is also possible to judge a direction automatically. If this is attached to a mobile robot, it is applicable to source-of-release detection of dangerous gas etc. There are few effective measurement means for a fine wind speed now. However, if it smells in the air, gas is emitted intentionally and the flow is visualized, this device can be used as a fine wind speed and an anemoscope. Although various smoke is conventionally used for visualization, it will sediment, if a wind speed becomes cm/s order. Since flattery nature [as opposed to a wind in a direction of a smell and gas] is high, this device is effective at a fine wind-speed place.

[0055](A 2nd embodiment) a pulse drive type semiconductor smell and a gas sensor were used -- although speed of response of a semiconductor smell and a gas sensor is quick, the degree of recovery fate of a smell and a gas stream visualization device is insufficient, and it affects visualization. So, in a 1st embodiment of the above, using a pulse drive type semiconductor smell and a gas sensor, a pulse shape of heater driver voltage is made the optimal, recovery speed is sped up, giving sensitivity equivalent to the conventional semiconductor smell and gas sensor, and a flow of ethano 1 RUGASU is visualized within an air duct. however, recovery speed of a sensor still judges a flow about tens seconds except the time of a jet start of starting, and a smell and gas, and an end -- language cannot be carried out.

[0056]So, a 2nd embodiment explains a case where a crystal oscillator smell and a gas sensor with quick response recovery speed are adopted as a sensor for the purpose of realization of a smell and a gas stream visualization device which can always judge a flow of a smell and gas.

[0057]Here, it takes first for starting a principle and a 2nd embodiment of a smell and a gas stream visualization device, and composition of - gas stream visualization device is explained. Then, a result of having conducted a visualization experiment of a smell and a gas stream within an air duct is shown.

[0058](Principle) a smell and a gas stream visualization device put in order a smell and a gas sensor of the same kind, constitutes a sensor array of several centimeters around, and passes through an it top -- moment distribution of a smell and gas is acquired as ******.

[0059]If there is no disorder in a wind, it will be a plume (generally, a diffusion rate of a smell and a gas molecule is dramatically slow, and a smell and a gas molecule mainly ride on a motion of a wind, and spreads in the shape of a cloud.). this cloud -- a plume -- calling -- it is extended without a break like an earnest belt from a smell and a gas source. However, a wind certainly has disorder actually and a plume serves as irregular and discontinuous shape. Thus, if a smell and a gas sensor follow instant change of concentration in order that it may take with complicated distribution and - gas may flow on an array, signs that distribution of a smell and gas flows can be visualized.

[0060]When a device concerning a 2nd embodiment detects a smell and a gas source, human being has the device itself in a hand, or it carries in a robot, and obtained and smells, the direction of - gas stream is followed, and a robot is moved.

[0061](A small crystal oscillator smell and a gas sensor) By such a principle, in order to visualize a flow of a smell and gas, each smell gas sensor must be able to follow a momentary concentration change of a smell and gas quickly. a case where a pulse drive type semiconductor smell and a gas sensor are used -- response recovery speed of a sensor -- ** -- < -- sufficient performance was not obtained. That is, a flow was not able to be ****(ed) immediately after a smell and a blow-of-gas start other than a smell and gas having flowed after a smell and a blow-of-gas stop with signs that an array is reached, and a smell and gas having checked last situation.

[0062]So, a 2nd embodiment considered adoption of a crystal oscillator smell and a gas sensor. Since a damping time constant of a crystal oscillator smell and a gas sensor is usually 1 or less second (Aoyagi, Nakamoto, and Moriizumi . Institute of Electronics, Information and Communication Engineers synthesis convention and 194.C-13-8 (1999)), improved efficiency of a device is expected. Since a sensor is mounted in a sensor array with high density, a sensor needs to be small. When it draws and influence of interference etc. is considered, a thing (oscillating circuit built-in small crystal oscillator) which happens easily in a high frequency circuit and which builds in an oscillating circuit is desirable.

[0063]For example, oscillating circuit built-in small crystal oscillators (FCXO-02, RIBAERE tech) used here are AT-cut and a silver electrode, and resonance frequency is 4x8 mm in 28 MHz and size. Using phosphatidylcholine, it applied to responsive membranes applied to the vibrator surface with a spray method so that a frequency shift might be set to 10 kHz.

[0064]According to a 1st embodiment, although ethanol gas was targeted, triethylamine was used here. a triethylamine smell being one of the offensive odors, and detecting the source of release -- environmental measurement -- it is useful. as opposed to this amine -- a ratio -- since it said that numerical sensitivity was large and response time of recovery was quick, a phosphatidylcholine film was chosen as responsive membranes.

[0065]A pulse drive type semiconductor smell and a gas sensor which uses drawing 8 (a) by a 1st embodiment. An example of a response waveform to triethylamine gas of a

small crystal oscillator smell and a gas sensor applied to a 2nd embodiment in an example of a response waveform to ethanol gas of (TGS2440 [for example,]) at drawing 8 (b) is shown. For example in an air duct (70 cm in width, 35 cm in height, and 80 cm in length) shown in drawing 4, measurement installed the sensors 3 and 103 on the lee at a 30-cm point from a nozzle (a smell and a gas source) which spouts a smell and gas, and measured a response (refer to drawing 4). A mean wind in an air duct is about 18 cm/second. However, spray velocity of a smell and gas is a part for 50-ml/in drawing 8 (a), and is a part for 75-ml/in drawing 8 (b).

[0066]Since even a wind in an air duct has disorder, a plume of a smell and gas moves in a zigzag direction irregularly, It is discontinuous (T. Yamanaka, H.Ishida, T.Nakamoto, T.Moriizumi, .Sensors and Actuators A, 69, 77-81 (1998)). For this reason, a momentary concentration change should have happened also in a position which installed a sensor. However, in a pulse drive type semiconductor smell and a gas sensor of drawing 8 (a), recovery is slow and a concentration change is not caught. Recovery after stopping a smell and a blow of gas is also slow. In a response waveform of a small crystal oscillator smell and a gas sensor of drawing 8 (b), a time-axis shows change of oscillating frequency [oscillating frequency / in the air / standard / (0 Hz)] in a smell and gas. It turns out that oscillating frequency has change in a smell and a blow of gas. While blowing off a smell and gas, recovery after have always caught a spike shape concentration change and stopping a smell and a blow of gas is also early.

[0067]Above, since kinds of a smell and gas also differ and environment, such as a wind speed, is also a little different, two measurement cannot be compared simply. However, if application of a smell and gas stream visualization device HE is considered, a momentary concentration change of a smell and gas can be quickly followed by using a crystal oscillator smell and a gas sensor, and a problem at the time of using a pulse drive type semiconductor smell and a gas sensor can be improved.

[0068](Equipment configuration) It takes using a small crystal oscillator smell and a gas sensor array, and composition of - gas stream visualization device is shown in drawing 9. This device can be divided roughly into the sensor array part 103, a multi-channel (for example, 25 channels (25ch)) frequency counter, the serial interface part 102 and the computer 1, and three.

[0069]A dispatch circuit built-in small crystal oscillator smell and a gas sensor which the sensor array part 103 described above, for example. (For example, FCXO-02, a RIBAERE tech) 103a -- a line writing direction and a column direction -- respectively -- every five pieces and total 5 -- x5=25 piece is uniformly arranged on a printed circuit board, and a sensor array is constituted in the shape of two dimensions. About array size of these 5x5 pieces, in order to obtain minimum data required for direction presumption, it determined from a reason for the ability to realize comparatively easily. an interval (distance of a center to center) of a sensor is 12.7 mm -- size of a sensor array -- hearing -- they are 50.8 mm x 50.8 mm. 25 sensor outputs (frequency change) of the sensor

array part 103 are incorporated into simultaneous parallel by 25ch frequency counter and the serial interface part 102 (sampling period: 1 second).

[0070]This 25ch frequency counter and the serial interface part 102 comprise FPGA (Field Programmable Gatearray), for example. Since an oscillating circuit built-in sensor was used, most circuits can be dedicated in FPGA, and a miniaturization of the whole device can be realized. In order to make wiring with an oscillating circuit and FPGA into the shortest and to prevent a surroundings lump from a power supply, 3 terminal chip capacitor was used for each one sensor of every, and a power supply and GND were bypassed. These measures can protect interference between oscillating circuits.

[0071]The sensor array part 103, a multi-channel frequency counter, and the serial interface part 102 of drawing 9 can consist of two-layer structures, for example. That is, the sensor array part 103 is mounted in the upper substrate, and an electric circuit of a multi-channel frequency counter and serial interface part 102 grade may be composition mounted in a lower layer substrate.

[0072]The computer 1 is a personal computer including a monitor, and it displays a smell and gas concentration distribution on a sensor array on a monitor as a picture (visualization picture of a smell and a gas stream) with four steps of gradation from a sensor response sent per second, for example while it controls the whole device. An output of each 25 sensor 103a appears as change of dispatch frequency of a crystal oscillator, and measures a smell and gas concentration distribution by measuring it. It is classified into four steps according to a threshold which specifically defined each sensor response suitably by the maximum response obtained after a measurement start, and gradation which is different in each stage is assigned. As such bright gradation, distribution of concentration is displayed as distribution of a color tone that a smell and gas concentration are high.

[0073]There is dispersion in sensitivity in each sensor 103a in the sensor array part 103. Then, it is desirable to proofread so that put and seal a container to the sensor array part 103 whole beforehand, and may expose all the sensors 103a to triethylamine gas of the same concentration, a response may be compared, it may multiply by a constant according to each sensor from this result and sensitivity of all the sensors may gather as much as possible.

[0074](Direction estimation algorithm) If a visualization picture of a smell and a gas stream is acquired by the device shown in drawing 9, human being can see and judge the direction of a smell gas stream. It is also possible to judge a direction automatically using various image processing algorithms. The personal computer 1 of drawing 9 can perform processing which judges a direction and the rate of flow from a visualization picture of this smell and gas stream.

[0075]It considers circuit-izing calculation in the future and performing real time processing here, the direction presuming method (T. -- Yamanaka, H.Ishida,

T.Nakamoto, T.Moriizumi, .Sensors and Actuators A, and 69, 77-81 (1998).) by a constrain equation of an easy optical flow of calculation B.K.P. Try an automatic judging of a direction using Horn, "robot vision" Asakura publication, and 305-328 (1993). Also in the field of image processing, this equation is well used, in order to restore relative motion of an object and a camera from a picture.

[0076]It is assumed that it flows on a sensor array in two dimensions while molecular diffusion of a smell and gas was disregarded, and it was visualized, it smelled and - gas concentration distribution had maintained fixed shape. If a response of v, and a smell and a gas sensor is set [x shaft-orientations (for example, line writing direction of sensor array) ingredient of a smell and a gas stream] to l for u and y shaft-orientations (for example, column direction of sensor array) ingredient, it will be a constrain equation of an optical flow, [0077]

[Equation 3]

$$\frac{\partial \ell}{\partial x} u + \frac{\partial \ell}{\partial y} v + \frac{\partial \ell}{\partial t} = 0 \qquad \cdots (5)$$

[0078]It becomes.

[0079]The SENNSA response of eye an i-th line j sequence is set with lij, and if differentiation included in an upper equation (5) is carried out to central-differences approximation, the following diffusion equations will be realized at the time k.

[0080]

[Equation 4]

$$\frac{\ell i+1j(k\Delta t)-\ell i-1j(k\Delta t)}{2\Delta d} u + \frac{\ell ij+1(k\Delta t)-\ell ij-1(k\Delta t)}{2\Delta d} v + \frac{\ell ij(k\Delta t+\Delta t)-\ell ij(k\Delta t-\Delta t)}{2\Delta d} = 0 \qquad \cdots (6)$$

[0081]However, deltad is a sensor interval (12.7 mm) and deltat is sampling time (1 second). The flow velocity vector (u, v) of a smell and a gas stream is not based on i and j, but thinks that it is fixed, and an upper type (6) is allied to i= 2, 3 and 4, j= 2, and 3 and 4, and it asks for u and v with a least-squares method.

[0082](Result)

(A smell and a gas stream visualization experiment) in the same air duct (the same air duct as drawing 4) as measurement of drawing 8, triethylamine gas of a small crystal oscillator smell and a gas sensor is received by the same environmental condition as drawing 8 -- a visualization experiment of a smell and a gas stream was conducted. However, in order to experiment under fine wind-speed environment, a wind speed was made into a second in about 3 cm /on an average. Performing one measurement for 300 seconds, 15 seconds of the beginning measured a baseline of a sensor, pushed

triethylamine gas collected on a gas part (head space) of the test tube upper part with an air pump after that, and blew off for 3 minutes by a part for flow/of 75 m.

[0083]An example of video obtained while blowing off a smell and gas is shown in drawing 10 (a) - (f). Drawing 10 is the binary-ized picture, its portion with high smell and gas concentration is black, and a low portion is displayed white. Drawing 10 (a) - (c) and (d) - (f) is the picture after both pass 60 seconds or more since a smell and a blow of gas, while [3 seconds] continuing, respectively. A lump of a smell and gas flows from the left, it flows into the right, and last situation is visualized.

[0084]In the case of a semiconductor smell and a gas sensor explained by a 1st embodiment, since the damping time constant was as long as tens of seconds, short-time measurement was difficult because of mutual interference etc., but measurement using a crystal oscillator smell and a gas sensor array of this embodiment usually has a damping time constant as quick as around 1 second, and a clear picture is acquired.

[0085]That is, in a 1st embodiment, only the beginning of a smell and a blow of gas and the last were able to be visualized as mentioned above, but in this device, a direction into which a smell and gas always [cheek] flow was able to be checked so that clearly from drawing 10. Since a plume fragmented by disorder of a wind passes through an array top by non-********, if a response and recovery of a sensor are quick, a direction into which a smell and gas always flow can be checked.

[0086](The automatic direction presumption by an algorithm) a 2nd embodiment is started in accordance with a described method -- direction presumption of a smell and a gas stream was performed from video obtained with a smell gas visualization device (direction estimation algorithm). The result is shown in drawing 11. As shown in drawing 11, distance from a smell and a gas source to a sensor array, A direction into which a smell and gas enter to a sensor array is made into a parameter, Condition 1:. 0 times Condition 4: entering of a sensor array -- a smell and a gas source to 20 cm -- the degree of incidence angle -- 0 times condition 2: -- entering of a sensor array -- a smell and a gas source to 20 cm -- the degree of incidence angle -45-degree condition 3: -- in entering of a sensor array, the degree of incidence angle at 30 cm from a smell and a gas source. entering of a sensor array -- a smell and a gas source to 30 cm -- the degree of incidence angle -a presumed experiment was conducted on each of this condition whose number is four to dynamic image data of a total of four batches of a case 45 degrees. Used data was used as data of a time of stopping a blow of gas from from immediately after gas reached a sensor array among those for 300 seconds. however -- since there is disorder in a wind in an air duct -- a wind direction -- a case where it was presumed by less than [+-45 degree] was considered as a correct answer.

[0087]In all the cases of the conditions 1 to the conditions 4, at least 49% was presumed in the correct answer direction. Considering disorder of a wind in an air duct, this can be called high answer rate. What expressed an estimation result of the conditions 4 with a histogram is shown in drawing 12. The correct answer direction is -45 degree and the

inside which lined off is a correct answer region. near the correct answer direction -- ** -- near a counter direction, it turns out to being presumed mostly that it is hardly presumed. In actual smell and gas source detection, it will smell, if an answer rate of this level is acquired, since direction presumption is performed at many places repeatedly, and it seems that source detection is possible.

[0088](Conclusion) a small crystal oscillator smell and a gas sensor with a built-in oscillating circuit which was described above were used -- according to a smell and the gas stream visualization device, signs that a smell and gas always flowed mostly have been checked to a smell and a gas stream of about 3 cm/second of mean winds. It was checked using an image processing algorithm based on a constrain equation of an optical flow to obtained video that the automatic direction presumption of a smell and a gas stream is possible.

[0089](A 3rd embodiment) A pulse drive type semiconductor smell and the gas sensor array 3 explained by a 1st embodiment, and a small crystal oscillator smell and a gas sensor array 103 which were explained by a 2nd embodiment are used, If a flow direction of a smell and a gas stream is not parallel to a sensor face (field where a smell and a gas sensor element of the sensor arrays 3 and 103 are arranged) when trying visualization of a smell and a gas stream, as shown in drawing 13 (a), In the sensor arrays 3 and 103, turbulence occurred on a sensor face, a smell and a gas stream disturbed the flow of a smell and a gas stream of a measuring object itself, and there was a flume problem that exact measurement of a flow of a smell and a gas stream could not be performed. That is, it is desirable for a sensor face of the sensor arrays 3 and 103 and a direction into which a smell and a gas stream flow to be always parallel. However, actually, since a flow direction measures strange smell and gas stream, a sensor face and a flow direction of a smell and a gas stream are not necessarily parallel.

[0090]Then, as shown in drawing 13 (b), a predetermined interval is consisted and a board (guide plate) parallel to a sensor face is arranged so that the whole sensor element on the sensor array 3 and 103 may be covered. Then, a smell and a gas stream which makes a sensor face center section as shown in drawing 13 (a) generate turbulence are covered with a guide plate, Only a smell (it passes along between a sensor face and guide plates) and a gas stream which passes along the surrounding opening can be incorporated and discharged, and, therefore, the sensor arrays 3 and 103 can take out and measure only an ingredient parallel to a sensor face among flow directions of a smell and a gas stream.

[0091]Drawing 14 forms the guide plate 201 above-mentioned in parallel so that a sensor face may be covered in the upper part of a sensor face of the sensor arrays 3 and 103 of a smell and a gas stream visualization device, and it shows a situation in a case of conducting a wind tunnel experiment. Although based also on conditions, such as a size of the sensor arrays 3 and 103, speed of a smell and a gas stream, and a direction, Here, it is in one side of the sensor arrays 3 and 103, or since it is about 5 cm, the guide

plate 201 of the almost same size as the sensor arrays 3 and 103 is about supported in a position around 1 cm high from a sensor face with a support stood to four angles of the sensor arrays 3 and 103, for example.

[0092]Thereby, since the sensor arrays 3 and 103 can take out and measure only an ingredient parallel to a sensor face among flow directions of a smell and a gas stream, they can measure a direction and speed of a smell and a gas stream more correctly.

[0093](A 4th embodiment) Drawing 15, it saw from a sensor face (detection face) of a pulse drive type semiconductor smell and the gas sensor array 3 explained by a 1st embodiment, and a small crystal oscillator smell and a gas sensor array 103 which were explained by a 2nd embodiment -- an active principle which can detect a direction and the rate of flow of a smell and a gas stream is shown.

[0094]As shown in drawing 15, when arbitrary points on a sensor face of the sensor arrays 3 and 103 are noted, the sensor arrays 3 and 103, A section which makes the sensor face and parallel direction the maximum sensing direction takes for crossing the curve m1 and m2 which are expressed with doughnut shape of a circle, and detects only the direction of - gas stream. That is, since a smell and the gas stream concerned do not cross the curve m1 and m2 which make an intersection the probe index on a sensor face by taking to a sensor face when the incidence angle theta of - gas stream is 90 degrees, the flow is undetectable. For example, by theta= 45 incidence angles, when a smell and a gas stream with a speed of 10 m/second consider the rate of flow of only an ingredient parallel to a sensor face, i.e., the surface, it serves as a reciprocal for costheta of the incidence angle theta, and will be measured with 10/cos45"=10/21/2.

[0095]When a sensor face is located to up-and-down both sides, a curve of a round form which faces across a sensor face as shown in drawing 15 serves as a sensitivity ingredient, and, in a sensor face, only in the case of the upper surface, the curve m1 and a semicircular state curve of m2 upper part serve as a sensitivity ingredient.

[0096]Therefore, if a sensor face measures visualization of a smell and a gas stream and a direction, and speed, using the sensor arrays 3 and 103 on top one sheet, a smell and a gas stream cannot be caught superficially [1]. However, since the direction of a smell and a gas stream and measurement of speed can be more correctly performed if a smell and a gas stream can be caught from many sides, this point is noted in this embodiment.

[0097]Then, it considers taking for starting this embodiment and using - gas stream visualization device combining two or more two-dimensional flat-surface top sensor arrays. For example, the sensor array A1 of two sheets, A2 As shown in drawing 16. (For example, two a pulse drive type semiconductor smell or the gas sensor array 3 explained by a 1st embodiment, or an array which were explained by a 2nd embodiment 103) [a small crystal oscillator smell and a gas sensor array] or one side with one each sufficient at a time -- xz flat surface -- another side -- yz flat surface -- it arranges so that it may cross mutually vertically, and a smell and a gas stream measuring part are constituted. The sensor array A1 which constitutes this smell and gas stream measuring

part, and each of A2 are connected to other apparatus of personal computer 1 grade, and a smell and a gas stream visualization device are constituted.

[0098]Then, as shown in drawing 17, a direction and speed of an ingredient (ingredient from which the incidence angle theta over a sensor face of the sensor array A1 of a smell and a gas stream will be 90 degrees) vertical to a sensor face of the sensor array A1 of a smell and a gas stream, Even if unknown from the sensor array A1, a smell and a gas stream can be caught in three dimensions by compounding speed of a smell and the gas stream concerned which could measure in a sensor face of the sensor array A2, and was measured by both sensor arrays A1 and each of A2, and a direction.

[0099]As an example in a case of using combining two or more sensor arrays, as shown in drawing 16, there is also how to combine as shown in drawing 18 also besides combining a sensor array of two sheets so that it may become vertical relations mutually. When calling it a sensor array below, both a pulse drive type semiconductor smell and the gas sensor array 3 explained by a 1st embodiment, and a small crystal oscillator smell and a gas sensor array 103 which were explained by a 2nd embodiment are contained.

[0100]Drawing 18 (a) carried out the sensor arrays 301a and 301b of two sheets to oppose each rear face (field where a sensor is not arranged), was combined and constituted, smells, and is - gas stream measuring part 300. In this smell and gas stream measuring part 300, by the sensor arrays 301a and 301b, it takes for flowing through the upper surface and undersurface side, and - gas stream can be detected.

[0101]each of the six sensor arrays 302a-302f is turned to a center section of each cubical (or rectangular parallelepiped) field, it turns the sensor face to an inside of cubical (or rectangular parallelepiped), and drawing 18 (b) is alike, sticks, and flows through the inside -- a case where a smell and a gas stream are measured is shown. Each field (or some fields of the six sheets) of a smell and the gas stream measuring part 310 of this cube (or rectangular parallelepiped) shape has structure which is passed without covering a smell and a gas stream in any way. and it flows through an inside of this cube (or rectangular parallelepiped) -- by compounding data produced by measuring a smell and a gas stream by the sensor arrays 302a-302f of each field, Also from a flow to which it came from which direction, from the 3rd [at least] page, if measurement is possible, the three-dimensional direction of a smell and the gas stream concerned and speed can be found by compounding the obtained data. A cube (or rectangular parallelepiped) shown here is in sensor arrays [302a-302f] sizes, or if it takes into consideration that it is 5 cm around, it will be a thing of a size length, width, and whose height are about 50 cm, for example, but it does not limit the size in particular.

[0102]Same effect is acquired, even if a sensor face is turned to the cubical (a certain **** is a rectangular parallelepiped) exterior and it sticks it. This case is shown in drawing 18 (c).

[0103]A smell and the gas stream measuring part 320 of cube (or rectangular

parallelepiped) shape shown in drawing 18 (c), a sensor face of the six sensor arrays 303a-303f is turned to the cubical (or rectangular parallelepiped) exterior, is looked like [a center section of each cubical (or rectangular parallelepiped) field], is stuck on it, and it flows through the exterior -- a smell and a gas stream are measured.

[0104]Spherical smell and gas stream measuring part 330 shown in drawing 18 (d) arrange a sensor array or the sensor element itself on a surface of a sphere of a predetermined size. Thus, a smell and a gas stream from all directions are easily measurable in three dimensions by providing a sensor array in as many directions as possible at one place.

[0105]A smell and the gas stream measuring part 320 (.) as shows drawing 18 (c) drawing 19, for example or any of each smell and gas stream measuring part which show drawing 18 (a) - (d) -- it may be -- an example of arrangement to a measurement place (for example, air duct) through which a smell and a gas stream of a smell and the gas stream measuring part 320 in a case of using and measuring a smell and a gas stream flow is shown.

[0106]A smell and the gas stream measuring part 320 are measurement places (here). using the wire rods 402a-402d from four angles of the upper part of cube shape -- a measurement place -- suspension being mostly used in the center section and, Each sensor arrays 303a-303f of a smell and the gas stream measuring part 320 are connected to other apparatus 403 of personal computer 1 grade, and a smell and a gas stream visualization device are constituted.

[0107]By having been constituted combining two or more sensor arrays, smelling, making a gas stream measuring part into suspension, and using it for a measurement place of a smell and a gas stream, as shown in drawing 19, Simultaneous multipoint measurement of the smell gas stream from all directions can be carried out, and a direction and speed of a smell and a gas stream can be measured more correctly.

[0108]By arranging a smell and a gas stream measuring part, as shown in drawing 19, a miniaturization of a smell and gas stream measuring part 320 the very thing is attained.

[0109]When it constitutes a smell and a gas stream measuring part combining two or more sensor arrays, a guide plate which was explained by a 3rd embodiment may be formed about one or some two or more sensor arrays of all or of them.

[0110]As mentioned above, although various examples were explained, this invention is not limited to these examples, can change variously, and can be applied.

[0111]

[Effect of the Invention]as explained above, according to this invention, it is not necessary to select the locating position of a gas sensor, and is hard to receive the influence of local disorder of a wind -- a short time -- reliability -- it is high -- the direction judging of a smell gas stream is attained.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]The figure showing the example of composition of the smell and gas stream visualization device concerning the embodiment of this invention.

[Drawing 2]The timing chart for explaining operation of the sensor array 3 of drawing 1.

[Drawing 3]The figure showing the response calibration curve over ethano 1 RUGASU of a pulse drive type semiconductor gas sensor.

[Drawing 4]The figure showing the example of the construction of wind tunnel which took using the smell and the gas stream visualization device, and conducted - gas stream visualization experiment.

[Drawing 5]The figure showing an example of the change accompanying the passage of time of the sensor response of five sensor elements on a par with a wind in parallel.

[Drawing 6]The figure showing an example of the video which visualized the sensor response of the sensor array 3.

[Drawing 7]The figure showing the table on which the result of having performed presumption of the direction of a gas stream and the rate of flow was summarized to the visualization picture shown in drawing 6.

[Drawing 8]The figure showing the example of the response waveform to the ethanol gas of the pulse drive type semiconductor smell and gas sensor (for example, TGS2440) used by a 1st embodiment, and the example of the response waveform to the triethylamine gas of the small crystal oscillator smell and gas sensor concerning a 2nd embodiment.

[Drawing 9]The figure in which having taken using the small crystal oscillator smell and the gas sensor array, and showing the example of composition of - gas stream visualization device.

[Drawing 10]The figure showing the example of the video obtained while blowing off a smell and gas.

[Drawing 11]The figure showing the direction estimation result of a smell and a gas stream from the video which took for starting a 2nd embodiment and was obtained with - gas visualization device.

[Drawing 12]The figure which expressed the direction estimation result (in the case of the conditions 4 of drawing 11) with the histogram.

[Drawing 13]The figure for explaining the measure to the turbulence generated on the sensor face of a sensor array.

[Drawing 14]The figure showing the situation in the case of conducting a wind tunnel experiment with the sensor array smell and gas stream visualization device with which the guide plate was formed.

[Drawing 15]it saw from the sensor face (detection face) of a sensor array -- the figure

showing the effective area which can detect the direction of a smell and a gas stream.
[Drawing 16]The figure in which having been constituted combining the sensor array of two sheets, having smelled, and showing an example of - gas stream measuring part.
[Drawing 17]The figure showing the effective area which can detect the direction of the smell and gas stream of the smell and gas stream measuring part of drawing 16.
[Drawing 18]The figure in which having been constituted combining two or more sensor arrays, having smelled, and showing other examples of - gas stream measuring part.
[Drawing 19]The figure showing the example of arrangement to the measurement place (for example, air duct) which was constituted combining two or more sensor arrays, and smells, and through which the smell gas stream of - gas stream measuring part flows.
[Description of Notations]
1 -- Personal computer
2 -- Control circuit
3 -- Sensor array (a pulse drive type semiconductor smell and a gas sensor array)
4 -- Logarithmic transformation circuit
5 -- A/D converter
102 -- A multi-channel frequency counter and serial interface part
103 -- Sensor array (a crystal oscillator smell and a gas sensor array)